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Section - 03
INSPECTION & TESTING

All materials furnished and all work performed under this Contract shall be inspected and tested. Deliverables shall not be shipped until all required inspections and tests have been completed, and all deficiencies have been corrected to comply with this Specification and approved for shipment by the Employer.

Except where otherwise specified, the Contractor shall provide all manpower and materials for tests, including testing facilities, logistics, power and instrumentation, and replacement of damaged parts. The costs shall be borne by the Contractor and shall be deemed to be included in the contract price.

The entire cost of testing for factory & site acceptance, routine tests, production tests and other test during manufacture & site activities specified herein shall be treated as included in the quoted unit price of materials, except for the expenses of Inspector/Employer's representative.

Acceptance or waiver of tests shall not relieve the Contractor from the responsibility to furnish material in accordance with the specifications.

All tests shall be witnessed by the Employer and/or its authorized representative (hereinafter referred to as the Employer) unless the Employer authorizes testing to proceed without witness. The Employer representative shall sign the test form indicating approval of successful tests.

Should any inspections or tests indicate that specific item does not meet Specification requirements, the appropriate items shall be replaced, upgraded, or added by the Contractor as necessary to correct the noted deficiencies at no cost to the Employer. After correction of a deficiency, all necessary retests shall be performed to verify the effectiveness of the corrective action.

The Employer reserves the right to require the Contractor to perform, at the Employer's expense, any other reasonable test(s) at the Contractor's premises, on site, or elsewhere in addition to the specified Type, Acceptance, Routine, or Manufacturing tests to assure the Employer of specification compliance.

3.1. Inspection

Access to the Contractor's facilities during system manufacturing and testing and to any facility where systems/ equipment are being produced/ tested/ integrated for the fibre optic communication network, shall be available to the Employer. At all times the Employer shall have full facilities for unrestricted inspection of such materials or equipment. To facilitate this, the Contractor shall submit for the Employer approval, a comprehensive Quality Assurance Plan using ISO 9000 as a general guideline. In addition, the Quality Assurance

Plan shall satisfy the following:

(a) Sufficient office facilities, equipment, and documentation necessary to complete all inspections and to verify that the equipment is being fabricated and maintained in accordance with the Specification shall be provided by the Contractor to the Employer.

(b) Inspections to be performed by the Employer will include visual examination of hardware, cable dressings and labeling. Contractor's documentation will also be examined to verify that it adequately identifies and describes all offered items and spare parts.

(c) Access to inspect the Contractor's standards, procedures, and records that are applicable to the supplied equipment shall be provided to the Employer. Documents will be inspected to verify that the Contractor has performed the required quality assurance activities.

(d) The inspection rights described above shall also apply to sub Contractors who are responsible for supplying major components described in this Specification. These items shall be inspected and tested at the sub Contractor's factory by the Employer's representatives prior to shipping this equipment to the Contractor's facility or directly to the Employer.

(e) The above inspection rights shall also apply to sub Contractors supplying assemblies, subassemblies and components. However, such items will normally be inspected and tested by the Employer's representatives at the Contractor's site before acceptance.

3.2. Test Plans and Procedures

Test plans for both factory and site acceptance tests shall be provided by the Contractor. Test plans shall be modular to allow individual test segments to be repeated upon request.

Procedures for type test, factory acceptance test, and site acceptance test for OPGW (including hardware accessories) have been provided in Appendix F, G & H respectively.

The Contractor shall submit a Test Schedule for the Employer's approval within one (1) week after the award of contract for Type Tests and three (3) months after the award of contract for all other tests. The test schedule shall list the tests to be carried out, and the approximate test duration. The test periods shall also be indicated in the PERT chart or equivalent for the work.

The Contractor shall give the Employer twenty one (21) days written notice of any material being ready for testing. Fifteen days prior to the scheduled testing, the Employer shall provide written notice to the Contractor of any drawings, equipment, material, or workmanship which, in the Employer’s opinion, are not compliant to the specification. The

Contractor shall give due consideration to such objections, if valid, effecting the corrections as necessary or shall prove, in writing, that said modifications are unnecessary for contract compliance.

3.2.1. Factory and Site Test Plans

A test plan for factory and site acceptance tests shall be submitted for approval, at least four (4) weeks before the start of testing. The test plan shall be a single overview document that defines the overall schedule and individual responsibilities associated with conducting the tests, documenting the test results, and successfully completing the test criteria. Test Plans shall include, at a minimum, the information contained in Table 3-1.

Table 3-1
Factory & field Test Plan Requirements

Item:	Description:
1.	Test schedule
2.	Record-keeping assignments, procedures and forms
3.	Procedures for monitoring, correcting and retesting variances
4.	Procedures for controlling and documenting all changes made to the communications equipment after the start of testing

3.2.2. Test Procedures

All test equipment and/or instruments shall bear calibration stickers indicating valid calibration on and beyond the testing date. The time lapsed since last calibration shall not exceed the test equipment/ jig manufacturer recommended calibration interval or the interval recommended in the test lab's internal quality procedures.

The Contractor shall ensure that all testing will be performed by qualified testing personnel well experienced in performing such tests.

3.2.3. Test Records

Complete and indexed records of all factory and site acceptance tests results shall be maintained and provided to the Employer by the Contractor in hardcopy. The records shall be keyed to the steps enumerated in the test procedures. The minimal items required in test records are described in Table 3-2.

Table 3-2
Test Record Requirements

Item:	Description:
1.	Test Title and Revision Level, if applicable; contract references
2.	Date and time for test start and test completed
3.	Test title and reference to the appropriate section of the test procedures
4.	Description of any special test conditions or special actions taken (Includes test-case data).

Table 3-2
Test Record Requirements

Item:	Description:
5.	Test results for each test segment including an indication of Passed, Conditional Pass, Incomplete or Failed.
6.	Test procedure modifications made during testing.
7.	Variance Report(s) tracking information and copies (if variance(s) was detected).
8.	Contractor's test engineer(s) identification, signature and remarks
9.	Employer's test witness identification, signature and remarks
10.	List of all attachments
11.	Attachments (including system logs, printouts, variances, hard copies of visual test result displays, etc.)

All principle test records, test certificates and performance curves shall be supplied for all tests carried out as proof of compliance with the specifications and/or each and every specified test. These test certificates, records and performance curves shall be supplied for all tests, whether or not they have been witnessed by the Employer within the specified duration after the completion of test. Information given on such test certificates and curves shall be sufficient to identify the material or equipment to which the certificates refer, and shall also bear the Contractor's reference and heading.

3.2.4. Rejection of Elements

Any item or component which fails to comply with the requirements of this Specification in any respect, at any stage of manufacture, test, erection or on completion at site may be rejected by the Employer either in whole or part as considered necessary.

Material or components with defects of such a nature that do not meet the requirements of the Specification by adjustment or modification shall be replaced by the Contractor at his own expense. After adjustment or modification, the Contractor shall submit the items to the Employer for further inspection and/or tests.

3.2.5. Test Periods Defined

The terminology used in Volume I, General Conditions of Contract and their correlation with the tests requirements described within this section is as follows:

Pre-Commissioning & Commissioning Period - The Site Acceptance Test (SAT)
Operational Acceptance - Successful completion of SAT

3.3. Type Testing

"Type Tests" shall be defined as those tests which are to be carried out to prove the design, process of manufacture and general conformity of the materials to this Specification. Type Testing shall comply with the following:

(a) OPGW, Fiber optic cable(ADSS/Approach Cable/UGFO) & and its Hardware fittings & accessories equipment being supplied shall conform to type tests as per technical specification.

(b) Validity period of type tests conducted on the OPGW, Fiber optic cable(ADSS/Approach Cable/UGFO) & and its Hardware fittings & accessories)- i.e. the period for which Type Test Reports shall remain valid and acceptable to employer provided no major change has been introduced in the basic design/technology/material/mechanical construction/functionalities / performance characteristic/manufacturing process, is as mentioned below :-

S.No.	Name of Equipment	Periodicity (in years)
1	OPGW	10
2	Fiber Optic cable (ADSS/ Approach Cable/UGFO)	10
3	Hardware fittings & accessories for OPGW & fiber optic cable	10

Note:- For all other equipment's validity of type test shall be 10 years from the originally scheduled last date of bid submission (Soft Copy)

Validity of test type reports shall be void in case of change in test procedure/method/criteria/test levels in case of revision/amendments to relevant standards.

In case of OPGW, the type tests conducted on OPGW design with 96fibers can be accepted for same OPGW design with 48 & 24fibers in line with IEEE 1138-2021 clause 6.3.

Further, the validity of Type Test reports shall be considered from Completion date of type testing up to the originally scheduled last date of bid submission (Soft Copy). The type tests of the equipment shall be repeated during its validity period, if there is change in technology, basic design, construction, electrical/ thermal/ mechanical stress, performance characteristics or materials employed or changes in manufacturing process, setup or combination of any of above. In case the type Test reports are not valid as per the conditions stipulated in this specification, the Contractor shall repeat the type tests at no extra cost to the employer/purchaser.

(c) Type tests shall not be required to be carried out if supplier has conducted these tests earlier on the same type of equipment and valid type test certificates are available. The test certificate shall be considered valid if,

i) Tests conducted earlier is either conducted in accredited laboratory (accredited based on ISO/IEC 17025 by the National Accreditation body of the country where laboratory is located) or witnessed by POWERGRID/representative authorized by POWERGRID/representative of Utility /representative of accredited test lab/ representative of The National Accreditation Board for Certification Bodies (NABCB) certified agency.

ii) Type test reports contain valid Calibration reports/ certificates of the relevant testing equipment, information pertaining to ratings, the relevant drawings, model number, test circuit, calculations (if any), photos, acceptance criteria/values specified in Technical Specification/ relevant standards (IS/ IEC) and compliance to the same.
and
iii) The Materials/Equipment shall be supplied from the same manufacturing works,

where from the sample was manufactured and successfully type tested as per relevant standard or at the works of Parent organization in case of technology transfer/ Joint Venture (JV) for the initial period of 03 years from the date of establishment of manufacturing plant.

In case of own manufacturing plant at different location within India, the type test of the original manufacturing works shall also be acceptable for the equipment manufactured and supplied from the different location subject to the following conditions:

a) the relevant standard does not bar the same,

b) the equipment being manufactured at different locations shall be identical in design, drawings, specifications, ratings to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),

c) the equipment being manufactured at different locations shall be identical in material & critical components, manufacturing process/practices, and quality control to that of the type tested sample in the original facility (where it was manufactured and successfully type tested),

d) Also, while submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking for above conditions (a), (b) and (c).

d) While submitting the Type Test Reports, the Original Equipment Manufacturer (OEM), shall furnish an undertaking with it declaring that there is:

i) No change in the Design
ii) No change in the material,
iii) No change in manufacturing process, and
iv) No amendment/ revision in the relevant standard as regard to type test conditions, since the type test.

e) In case the tests have been conducted earlier than the above stipulated period or carried out on samples manufactured from any other manufacturing works or in case of revision/ amendment in the provisions/ test procedure of the IS/IEC as referred in the TS or in the event of any discrepancy in the test report (i.e., due to non-inclusion of validity details of calibration certificate, desired information etc. or any test not applicable due to any design/ material/ manufacturing process change including substitution of components or due to non-compliance with the requirement stipulated in the Technical Specifications), the tests shall be conducted by the supplier at no extra cost to the Purchaser

The type test reports of hardware fittings and vibration dampers approved with a particular make of OPGW Cable, shall be accepted with OPGW designs of other manufacturers also (where both are Standard OPGW designs having similar parameters such as diameter, UTS, etc.)

In the event of any discrepancy in the test reports i.e. any test report not acceptable due to any design/manufacturing changes or due to non-compliance with the requirement stipulated in the Technical Specification or any/all type tests not carried out, same shall be carried out without any additional cost implication to the Employer.

The Contractor shall provide a detailed schedule for performing all specified type tests at least two (2) weeks in advance.

f) The Contractor shall ensure that all type tests can be completed within the time schedule offered in his Technical Proposal.

g) In case of failure in any type test, the supplier is either required to manufacture fresh sample lot and repeat the entire tests successfully once or repeat that particular type test three times successfully on the sample selected from the already manufactured lot at his

own expense. In case a fresh lot is manufactured for testing then the lot already

manufactured shall be rejected.

If repeat type tests are required to be conducted, then all the expenses for deputation of inspector/purchaser's representative shall be to the supplier's account. Also, on receipt of the supplier's notice of testing, the purchaser's representative does not find the test samples or testing facilities/equipment ready for testing, the expenses incurred by the purchaser for re-deputation shall be to the supplier's account.

3.3.1. Type Test Samples

The Contractor shall supply equipment/material for sample selection only after the Quality Assurance Plan has been approved by the Employer. The sample material shall be manufactured strictly in accordance with the approved Quality Assurance Plan. The Contractor shall submit for Employer approval, the type test sample selection procedure. The selection process for conducting the type tests shall ensure that samples are selected at random. At least three samples of each of the proposed equipment/item/cable drum except FO cable installation hardware & fittings shall be offered for selection. For FO cable installation hardware & fittings at least ten (10) samples shall be offered for selection.

3.3.2. List of Type Tests

The type testing shall be conducted on the following equipment/items

(a) Optical fibres
(b) OPGW Cable
(c) OPGW Cable fittings
(d) Vibration Damper
(e) Splice Enclosure (Joint Box)
(f) Approach Cable
(g) ADSS & its hardware fittings
(h) UGFO & its associated items

Further, tests on various items other than those listed in this section of technical specifications but otherwise mentioned in relevant general requirements (GR) issued by Telecommunication Engineering Centre (TEC), DoT are also to be completed in compliance to Department of Telecommunications(DoT), Ministry of Communications order dated 29.08.2018 on 'Public Procurement (Preference to Make In India) Order 2017 –Notification of Telecom products, Services or Works – regarding".

3.3.2.1. Type Tests for Optical Fibres

The type tests listed below in table 3-3 shall be conducted on DWSM fibres to be supplied as part of overhead cables. The tests specific to the cable type are listed in subsequent sections.

Table 3-3
Type Tests for Optical Fibres

S. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation	As per Section-02 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A
2	Attenuation Variation with Wavelength	As per Section-02 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A
3	Attenuation at Water Peak	As per Section-02 of TS	IEC 60793-1-40 Or EIA/TIA 455-78A
4	Temp. Cycling (Temp dependence of Attenuation)		IEC 60793-1-52 Or EIA/TIA 455-3A, 2 cycles
5	Attenuation With Bending (Bend Performance)		IEC 60793-1-47 Or EIA/TIA 455-62A
6	Mode Field dia.		IEC 60793-1-45 Or EIA/TIA 455-164A/167A/174
7	Chromatic Dispersion		IEC 60793-1-42 Or EIA/TIA 455-168A/169A/175A
8	Cladding Diameter		IEC 60793-1-20 Or EIA/TIA 455-176
9	Point Discontinuities of attenuation		IEC 60793-1-40 Or EIA/TIA 455-59
10	Core -Clad concentricity error		IEC 60793-1-20 Or EIA/TIA 455-176
11	Fibre Tensile Proof Testing		IEC 60793-1-30 Or EIA/TIA 455-31B
-End Of table-			

3.3.2.2. Type Tests for OPGW Cables

The type tests to be conducted on the OPGW cable are listed in Table 3-4 Type Tests for OPGW Cables. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table 3-4

Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure
1	Water Ingress Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.5
2	Seepage of filling compound	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.6
3	Short Circuit Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.3
4	Aeolian Vibration Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.1
5	Galloping test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.2
6	Cable Bend Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.2.3
7	Sheave Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.2.1
8	Crush Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.2.2
9	Twist Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.2.4
10	Creep Test	IEEE 1138-	IEEE 1138-2021

Table 3-4
Type tests for OPGW Cable

S. No.	Test Name	Test Description	Test Procedure
		2021	Method 6.5.1.1
11	Strain Margin Test or MRDT Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.1.3
12	Stress Strain Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.1.2
13	Temperature Cycling Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.7
14	Corrosion (Salt Spray) Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.8
15	Ultimate Tensile Strength Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.1.4
16	Lightning Arc Test	IEEE 1138-2021	IEEE 1138-2021 Method 6.5.3.4
17	DC Resistance Test	IEEE 1138-2021	IEEE 1138-2021Method 6.5.1.5

In addition to the tests mentioned above, the tests specified under the relevant TEC GR (mentioned below) shall also be conducted in accordance with the test procedures prescribed in the TEC-GR standard.

1	Impact Test	TEC GR	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-021/01/SEP-11
2	Repeated Bend Test	TEC GR	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-021/01/SEP-11
3	Tensile test on Aluminum Clad Steel Wire	TEC GR	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-021/01/SEP-11

4	Elongation at break test on Aluminum Clad Steel Wire	TEC GR	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-021/01/SEP-11
5	Twist/Torsion test on Aluminum Clad Steel Wire	TEC GR	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-021/01/SEP-11
6	Lay length measurement Test	TEC GR	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-021/01/SEP-11
-End Of Table-			

3.3.2.3. Type Test on OPGW Cable Fittings

The type tests to be conducted on the OPGW Cable fittings and accessories are listed below:

(i) Mechanical Strength Test for Suspension/Tension Assembly

Applicable Standards: IEC 61284, 1997.

Suspension Assembly

The armour rods /reinforcement rods are assembled on to the approved OPGW using the Installation Instructions to check that the assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:
The suspension assembly shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased and held for one minute for the test rig to stabilise. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. The angle between the cable, the Suspension Assembly and the horizontal shall not exceed 16°. This load shall then be removed in a controlled manner and the Protection Splice disassembled. Examination of all the components shall be made and any evidence of visual deformation shall be documented.

Part 2:
The Suspension clamp shall then be placed in the testing machine. The tensile load shall gradually be increased up to 50% of the specified Minimum Failure Load of the Suspension Assembly and held for one minute for the Test Rig to stabilise and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.

Tension Assembly

The Tension Assembly is correctly fitted and is the same that will be carried out during installations.

Part 1:
The tension assembly (excluding tension clamp) shall be increased at a constant rate up to a load equal to 50% of the specified minimum Failure Load increased at a constant rate and held for one minute for the test rig to stabilise. The load shall then be increased at a steady rate to 67% of the minimum Failure Load and held for five minutes. This load shall then remove in a controlled manner and the Tension Assembly disassembled. Examination of the Tension Dead-End and associated components shall be made and any evidence of visual deformation shall be documented.

Part 2:
The Tension Dead-End and associated components shall then be reassembled and bolts tightened as before. The tensile load shall gradually be increased up shall gradually be increased up to 50% of the specified Minimum Failure Load of the Tension Assembly and held for one minute for the Test Rig to stabilise and the load shall be further increased at a steady rate until the specified minimum Failure Load is reached and held for one minute. No fracture should occur during this period. The applied load shall then be increased until the failing load is reached and the value shall be documented.

Acceptance Criteria for Tension/Suspension Assembly:

- No evidence of binding of the Nuts or Deformation of components at end of Part 1 of Test.
- No evidence of Fracture at the end of one minute at the minimum failure load during Part 2 of the Test.

Any result outside these parameters shall constitute a failure.

(ii) Clamp Slip Strength Test for Suspension Assembly

The suspension assembly shall be vertically suspended by means of a flexible attachment. A suitable length fibre optical cable shall be fixed in the clamps. Once the Suspension Clamp has been assembled, the test rig is tensioned to 1 kN and the position scale on the recorder 'zeroed'. The test rig is then tensioned to 2.5 kN and the relative positions of the Reinforcing Rods, Armour Rods and Suspension Clamp shall be marked by a suitable means to confirm any slippage after the test has been completed. The relative positions of the helical Armour Rods and associated Reinforcing Rods at each end shall be marked and also 2 mm relative position between clamp body and Armour Rods shall be marked on one side. The load shall be increased to 12 kN at a loading rate of 3 kN/min and held for one minute. At the end of this one minute period, the relative displacement between clamp body and the armour rods shall be observed. If the slippage is 2 mm or above, the test shall be terminated. Otherwise, at the end of one minute the position of the clamp body and 2 mm. relative positions between clamp body and armour rods shall be marked on the other side. After the one minute pause, the load shall be further increased at a loading rate of 3 kN/min, and recording of load and displacement shall continue until either the relative Position displacement between clamp body and armour rods reaches more than 2 mm or the load reaches the maximum slip load of 17 kN. On reaching either of the above values the test is terminated. Visual examination of all paint marks shall be recorded, and a measurement of any displacement recorded in the Table of Results.

Acceptance Criteria:

The Suspension Clamp has passed the Slip Test if the following conditions are met:

- No slippage* shall occur at or below the specified minimum slip load.

  * Definition of no slippage in accordance with IEC 61284, 1997:- Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the cable as a result of the test itself are not regarded as slippage.

- Slippage shall occur between the specified maximum and minimum slip load of 12-17 kN.

- There shall be no slippage of the Reinforcing Rods over the cable, and no slippage of the Armour Rods over the Reinforcing Rods.

- The relative movement (i.e. more than 2 mm between Armour Rods & Clamp body) between minimum 12 kN and maximum slip 17 kN, shall be considered as slip.

- The Armour Rods shall not be displaced from their original lay or damaged**.

  ** Definition of no damage in accordance with convention expressed in IEC 61284: 1997 no damage, other than surface flattening of the strands shall occur.

Any result outside these parameters is a failure.

(iii) Slip Strength Test of Tension Clamp

Tension clamps shall be fitted on a 8 m length of fibre optic cable on both ends. The assembly shall be mounted on a tensile testing machine and anchored in a manner similar to the arrangement to be used in service. A tensile load shall gradually be applied up to 20 % of the UTS of OPGW. Displacement transducers shall be installed to measure the relative movement between the OPGW relative to the Reinforcing Rods and Tension Dead -End relative to Reinforcing Rods. In addition, suitable marking shall be made on the OPGW and Dead-End to confirm grip. The load shall be gradually increased at a constant rate up to 50 % of the UTS and the position scale of the recorder is zeroed. The load shall then gradually increased up to 95 % of the UTS and maintained for one minute. After one minute pause, the load shall be slowly released to zero and the marking examined and measured for any relative movement.

Acceptance Criteria:

- No movement* shall occur between the OPGW and the Reinforcing Rods, or between the Reinforcing Rods and the Dead-End assembly.
- No failure or damage or disturbance to the lay of the Tension Dead-End, Reinforcing Rods or OPGW.

* Definition of no movement as defined in IEC 61284: Any relative movement less than 2 mm is accepted. The possible couplings or elongations produced by the conductor as a result of the test itself are not regarded as slippage.

Any result outside these parameters shall constitute a failure.

(iv) Grounding Clamp and Structure Mounting Clamp Fit Test

For structure mounting clamp, one series of tests shall be conducted with two fibre optic cables installed, one series of tests with one fibre optic cable installed in one groove, and one series of tests with one fibre optic cable in the other groove. Each clamp shall be installed including clamping compound as required on the fibre optic cable. The nut shall be tightened on to the bolt by using torque wrench with a torque of 5.5 kgm or supplier's recommended torque and the tightened clamp shall be held for 10 minutes. After the test remove the fibre optic cable and examine all its components for distortion, crushing or breaking. Also the fibre optic cable shall be checked to ensure free movement within the core using dial callipers to measure the diameter of the core tube. The material shall be defined as failed if any visible distortion, crushing, cracking or breaking of the core tube is observed or the fibre optic cable within the core tube is not free to move, or when the diameter of the core tube as measured at any location in the clamped area is more than 0.5 mm larger or smaller of the core diameter as measured outside the clamped area.

(v) Structure Mounting Clamp Strength Test

The clamp and mounting assembly shall be assembled on a vertical 200 mm x 200 mm angle and a short length of fibre optic cable installed. A vertical load of 200 kg shall be applied at the end of the mounting clamp and held for 5 minutes. Subsequently, the load shall be increased to 400 kg and held for 30 seconds. Any visible distortion, slipping or breaking of any component of the mounting clamp or assembly shall constitute failure.

3.3.2.4. Type Test on Vibration Damper

(a) Dynamic Characteristic Test

The damper shall be mounted with its clamp tightened with torque recommended by the manufacturer on shaker table capable of simulating sinusoidal vibrations for Critical Aeolian Vibration frequency band ranging from 0.18/d to 1.4/d – where d is the OPGW cable diameter in meters. The damper assembly shall be vibrated vertically with a ±1 mm amplitude from 5 to 15 Hz frequency and beyond 15 Hz at 0.5 mm to determine following characteristics with the help of suitable recording instruments.

(i) Force Vs frequency

(ii) Phase angle Vs frequency

(iii) Power dissipation Vs frequency

The Force Vs frequency curve shall not show steep peaks at resonance frequencies and deep troughs between the resonance frequencies. The resonance frequencies shall be suitably spread within the Aeolian vibration frequency-band between the lower and upper dangerous frequency limits determined by the vibration analysis of fibre optic cable without dampers.

Acceptance criteria for vibration damper:

(i) The above dynamic characteristics test on five damper shall be conducted.
(ii) The mean reactance and phase angle Vs frequency curves shall be drawn with the criteria of best fit method.
(iii) The above mean reactance response curve should lie within following limits:
V.D. for OPGW - 0.060 f to 0.357 f kgf/mm*

Where f is frequency in Hz.

(iv) The above mean phase angle response curve shall be between 25° to 130° within the frequency range of interest.

(v) If the above curve lies within the envelope, the damper design shall be considered to have successfully met the requirement.

Visual resonance frequencies of each mass of damper is to be recorded and to be compared with the guaranteed values.

(b) Vibration Analysis

The vibration analysis of the fibre optic cable shall be done with and without damper installed on the span. The vibration analysis shall be done on a digital computer using energy balance approach. The following parameters shall be taken into account for the purpose of analysis.

(i) The analysis shall be done for single fibre optic cable without armour rods. The tension shall be taken as 25% of UTS of fibre optic cable for a span ranging from 100 m to 1100 m.

(ii) The self damping factor and flexural stiffness (EI) for fibre optic cable shall be calculated on the basis of experimental results. The details to experimental analysis with these data shall be furnished.

(iii) The power dissipation curve obtained from Damper Characteristics Test shall be used for analysis with damper.

(iv) Examine the Aeolian Vibration level of the fibre optic cable with and without vibration damper installed at the recommended location or wind velocity ranging from 0 to 30 Km per hour, predicting amplitude, frequency and vibration energy input.

(v) From vibration analysis of fibre optic cable without damper, antinode vibration amplitude and dynamic strain levels at clamped span extremities as well as antinodes shall be examined and thus lower and upper dangerous frequency limits between which the Aeolian vibration levels exceed the specified limits shall be determined.

(vi) From vibration analysis of fibre optic cable with damper(s) installed at the recommended location, the dynamic strain level at the clamped span extremities, damper attachment point and the antinodes on the fibre optic cable shall be determined. In addition to above damper clamp vibration amplitude and antinodes vibration amplitudes shall also be examined.

The dynamic strain levels at damper attachment point, clamped span extremities and antinodes shall not exceed the specified limits. The damper clamp vibration amplitude shall not be more than that of the specified fatigue limits.

(c) Fatigue Tests

(i) Test Set Up

The fatigue tests shall be conducted on a laboratory set up with a minimum effective span length of 30m. The fibre optic cable shall be tensioned at 25% of UTS of fibre optic cable and shall not be equipped with protective armour rods at any point.

Constant tension shall be maintained within the span by means of lever arm arrangement. After the fibre optic cable has been tensioned, clamps shall be installed to support the fibre optic cable at both ends and thus influence of connecting hardware fittings are eliminated from the free span. The clamps shall not be used for holding the tension on the fibre optic cable. There shall be no loose parts, such as suspension clamps, U bolts, on the test span supported between clamps mentioned above. The span shall be equipped with vibration inducing equipment suitable for producing steady standing vibration. The inducing equipment shall have facilities for step less speed control as well as step less amplitude arrangement. Equipment shall be available for measuring the frequency, cumulative number of cycles and amplitude of vibration at any point along the span.

(ii) Fatigue Test

The vibration damper shall be installed on the test span with the manufacturer's specified tightening torque. It shall be ensured that the damper shall be kept minimum three loops away from the shaker to eliminate stray signals influencing damper movement.

The damper shall then be vibrated at the highest resonant frequency of each damper mass. For dampers involving torsional resonant frequencies, tests shall be done at torsional modes also in addition to the highest resonant frequencies at vertical modes. The resonance frequency shall be identified as the frequency at which each damper mass vibrates with the maximum amplitude on itself. The amplitude of vibration of the damper clamp shall be maintained not less than ±25/f mm where f is the frequency in Hz.

The test shall be conducted for minimum ten million cycles at each resonant frequency mentioned above. During the test, if resonance shift is observed, the test frequency shall be tuned to the new resonant frequency.

The clamp slip test as mentioned herein shall be repeated after fatigue tests without retorquing or adjusting the damper clamp, and the clamp shall withstand a minimum load equal to 80% of the slip strength for a minimum duration of one minute.

After the above tests, the damper shall be removed from fibre optic cable and subjected to dynamic characteristics test. There shall not be any major deterioration in the characteristics of the damper. The damper then shall be cut open and inspected. There shall not be any broken, loose, or damaged part. There shall not be significant deterioration or wear of the damper. The fibre optic cable under clamp shall also be free from any damage.

For purposes of acceptance, the following criteria shall be applied:

(1) There shall not be any resonant frequency shift before and after the test by more than ± 20%

(2) The power dissipation of the damper before and after test at the individual resonant frequencies do not differ by more than ± 20%

Beside above tests, the type tests listed below in the table shall also be conducted on Vibration Damper

Sl No.	Test Name	Test Procedure
1	Visual examination & Dimensional and material verification	IEC 61897 Clause 7.1 & 7.2
2	Clamp Slip test	IEC 61897 Clause 7.5
3	Clamp bolt tightening test	IEC 61897 Clause 7.7
4	Attachments of weights to messenger cable	IEC 61897 Clause 7.8
5	Attachment of clamps to messenger cable	IEC 61897 Clause 7.8
6	Damper effectiveness evaluation	IEC 61897 Clause 7.11.3.2

3.3.2.5. Type Tests for Splice Enclosures (Joint Box)

Following Type tests shall be demonstrated on the Splice Enclosure(s) (Splice Enclosure/Box). For certain tests, lengths of the fibre optic cable shall be installed in the splice box, and the fibres must be spliced and looped in order to simulate conditions of use. The attenuation of the fibres shall be measured, during certain tests, by relevant Fibre Optic Test Procedures (EIA/TIA 455 or IEC 60794-1 procedures).

(i) Temperature Cycling Test

FO cable is installed in the splice enclosure and optical fibres spliced and looped. The box must be subjected to 5 cycles of temperature variations of -40°C to +65°C with a dwell time of at least 2 hours on each extreme.

Fibre loop attenuation shall be measured in accordance with EIA 455-20 / IEC 60794-1-C10. The variation in attenuation shall be less than ±0.05dB. The final humidity level, inside the box, shall not exceed the initial level, at the closing of the box.

(ii) Humid Heat test

The sealed splice enclosure, with fibres spliced and looped inside, must be subjected to a temperature of +55°C ±2°C with a relative humidity rate of between 90% and 95% for 5 days. The attenuation variation of the fibres during the duration of the test shall be less than ±0.05dB, and the internal humidity rate measured, less than 2%.

(iii) Water Immersion test

The splice enclosure with optical fibres cable installed and fibres spliced fixed, shall be immersed in water for 24 hours. No water seepage or moisture shall be detected in the splice enclosure. The attenuation variation of the fibres after the test shall be less than ±0.05dB.

(iv) Vibration Test

The splice enclosure, with fibres united inside, shall be subjected to vibrations on two axes with a frequency scanning of 5 to 50 Hz. The amplitude of the vibrations shall be constant at 0.450mm, peak to peak, for 2 hours, for each of the vibrations' axes. The variation in attenuation, of the fibres, shall be less than ±0.05dB. The splice enclosure shall be examined for any defects or deformation. There shall be no loosening or visible damage of the FO

cable at the entry point.

(v) Bending and Torsion test

The splice enclosure, with fibres spliced inside, shall be firmly held in place and be subjected to the following sequence of mechanical stresses on the cable:

a) 3 torsion cycles of ±180° shall be exercised on the cable. Each cycle shall be less than one minute.

b) 3 flexure cycles of the cable, of ±180° with one cycle less than one minute.

The variation in the attenuation, of the fibres, shall be less than ±0.05dB. The cables connection ring shall remain securely fixed to the box with the connection maintained firmly. No defects/fissures shall be noted on the joint ring or on the splice enclosure

(vi) Tensile test

The splice enclosure with cable fixed to the boxes shall be subjected to a minimum tension of 448 N for a period of two minutes. No fissure shall be noted in the connections or on the box.

(vii) Drop Test

With 2 lengths of 11metres of cable fixed to the box, it shall be dropped five times from a height of 10metres. There shall be no fissure, at all, of the box, and the connections shall remain tight. The test surface shall be carried out in accordance with IEC 60068-2-32.

In addition to the tests mentioned above, the tests specified under the relevant TEC GR (mentioned below) shall also be conducted in accordance with the test procedures prescribed in the TEC-GR standard.

S.NO.	Test Name	Test Procedure
1	Gas (AIR) Tightness Test	TEC/GR/TX/OFC-021/01/SEP-11
2	Variation in attenuation (Residual Loss) Test	TEC/GR/TX/OFC-021/01/SEP-11
3	Cable Clamping	TEC/GR/TX/OFC-021/01/SEP-11
4	Impact Test	TEC/GR/TX/OFC-021/01/SEP-11
5	Torsion Test	TEC/GR/TX/OFC-021/01/SEP-11
6	Flexure Test	TEC/GR/TX/OFC-021/01/SEP-11
7	Static Load Test	TEC/GR/TX/OFC-021/01/SEP-11
8	Thermal Aging	TEC/GR/TX/OFC-021/01/SEP-11
9	Salt spray (Mist) Test (Corrosion Test)	TEC/GR/TX/OFC-021/01/SEP-11

10	Current Surge Test	TEC/GR/TX/OFC-021/01/SEP-11
11	UV test	TEC/GR/TX/OFC-021/01/SEP-11
-End Of Table-		

3.3.2.6. Type Tests for Fibre Optic Approach Cable

The type tests to be conducted on the Fibre Optic Approach cable are listed in table 3-5: Type Tests for Fibre Optic Approach Cable. Unless specified otherwise in the technical specifications or the referenced standards, the optical attenuation of the specimen, measured during or after the test as applicable, shall not increase by more than 0.05 dB/Km.

Table 3-5:
Type Tests Fibre Optic Approach Cable

S.NO.	Test Name	Test Procedure
1	Water Ingress Test	(IEC 60794-1-F5 / EIA 455-82B) Test duration : 24 hours
2	Seepage of filling compound	(EIA 455-81A) Preconditioning : 72 hours, Test duration : 24 hours.
3	Crush Test	(IEC 60794-1-E3/ EIA 455-41)
4	Impact Test	(IEC-60794-1-E4/ EIA 455-25A)
5	Stress strain Test	(EIA 455-33A)
6	Cable Cut-off wavelength Test	(EIA 455-170)
7	Temperature Cycling Test	(IEC60794-1-F1/EIA-455-3A) – 2 cycles
-End Of Table-		

In addition to the tests mentioned above, the tests specified under the relevant TEC GR (mentioned below) shall also be conducted in accordance with the test procedures prescribed in the TEC-GR standard

S.NO.	Test Name	Test Procedure
1	Cable aging Test (Type Test)	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-20/01/MAR-2011
2	Test of Figure of 8 (Eight) on the cable (Type Test)	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-20/01/MAR-2011
3	Flexural Rigidity Test on the optical fibre cable (Type Test)	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-20/01/MAR-2011
4	Static Bend test (Type Test)	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-20/01/MAR-2011

5	Kink Test	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-20/01/MAR-2011
6	To Check of the quality of the loose tube (containing optical fibre) (Type Test): a. Embrittlement Test	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-20/01/MAR-2011
7	Drainage Test for Loose Tube and Drip test on the cable (Type Test): a. Drainage Test for loose Tube b. Drip test on the cable	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-20/01/MAR-2011
8	Check of the effect of aggressive media on the cable (Acidic and Alkaline Behaviour) (Type Test)	GENERIC REQUIREMENTS NO. TEC/GR/TX/OFC-20/01/MAR-2011

3.3.2.6.1. Impact Test

The Impact test shall be carried out in accordance with IEC:60794-1-E4. Five separate impacts of 2.0 kg shall be applied at different locations. The radius of the intermediate piece shall be the reel drum radius ± 10%. A permanent or temporary increase in optical attenuation value greater than 0.05 dB/km shall constitute failure.

3.3.2.7. Type Testing on Aerial Optical Fibre Cable

The Bidder shall have valid Type Approval Certificate (TAC) from TEC/Technical Specification Evaluation Certificate(TSEC) given by BSNL QA for 24F/48F Self Supporting Metal Free Aerial Fibre Optic Cable (ADSS) OFCs suitable for Power Systems preferably for snow areas at the date of bid opening and a copy of valid TAC/TSEC certificate shall be submitted and proof for submission shall be submitted along with the bid. However, the bidder shall ensure that in all the cases the TSEC/TEC certificate would be valid at the time of award. In case type approval certificate validity expires after placement of Letter of Award (LoA), the contractor shall take advance action so that the supply is not delayed due to non-availability of type approval certificate for the offered fibre optic cable meeting the requirement. In case, TSEC/TEC certificate of Self Supporting Metal Free Aerial Fibre Optic Cable (ADSS) Optical fiber cable is not available, the Contractor shall submit the previously carried out type test report for the same design of cable for the tests listed in Table 3-6 below. The fibre should have been type tested as per relevant indian standards/International standards for the tests listed in Table-3-3 and the Bidder shall submit the test reports and certificates along with the bid.

The mechanical and testing parameters of the cable shall meet the requirements defined in Table 3-6 below:

Table 3-6

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement

1	Tensile strength Test	To test the tensile strength Self Supporting Metal Free aerial Optical Fibre cable in order to examine the behaviour of the attenuation as a function of the load on a cable during installation and while the aerial optical fibre cable encounters the excess ice loading and the winds at high speed and to check its design parameters.	IEC 794-1-E1 The cable shall sufficient strength to withstand UTS load. The load shall be sustained for 10 minutes and the strain of the fibre and the attenuation shall be monitored at MWT, Max installation load & UTS. MWT & UTS shall be derived from SAG-TENSION data for aerial cable.	The load shall produce no strain (≤0.05% is to be treated as no strain) up to MWT and fibre strain shall not exceeding 0.25% in the fibre upto max installation load. At UTS fibre shall not break and shall not cause any permanent physical and optical damage to any component of the cable. The attenuation shall be noted before strain and after the release of strain. The change in attenuation of each fibre after the test shall be ≤ 0.05dB

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
				both for 1310 nm and 1550 nm wavelength.
2	Abrasion Test	To test the abrasion resistance of the sheath and the marking printed on the surface of the cable.	IEC-794-1-E2 or by any other international test method The cable surface shall be abraded with needle (wt. 150 gm) having diameter of 1mm with 500 grams weight (Total weight more than equal 650 gms.) No. of cycles : 100 Duration : One minute (nominal)	There shall be no perforation & loss of legibility of the marking on the sheath.

3	Crush Test (Compressive Test)	The purpose of this test is to determine the ability of an optical fibre cable to withstand crushing.	IEC 794-1-E3 The fibres and component parts of the cable shall not suffer permanent damage when subjected to a compressive load of 2000 Newtons applied between the plates of dimension 100 x 100 mm. The load shall be applied for 60 Secs. The attenuation shall be noted before and after the completion of the test.	The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310 nm and 1550 nm wavelength.
4	Impact Test	The purpose of this is to determine the ability of an optical fibre cable to withstand impact.	IEC 794-1-E4 The cable have sufficient strength to withstand an impact caused by a mass weight of 50 Newtons, when falls freely from a height of 0.5 meters. The radius R of the surface causing impact shall be 300 mm. Ten such impacts shall be applied at the same place. The attenuation shall be noted before and after the completion of the test.	The change in attenuation of the fibre after the test shall be ≤ 0.05 db both for 1310 nm and 1550 nm wavelength.

5	Repeated bending	The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated bending.	EIA-455-104 The cable sample shall be of sufficient length (5 m minimum to permit radiant power measurements as required by this test. Longer lengths may be used if required. Parameters : Weight : 5 kg Minimum distance from Pulley Centre:216mm To holding device Minimum distance from Wt. To Pulley Centre : 457 mm Pulley Diameter: 20 D (D-cable diameter) Angle of Turning: 90° No. Time Required for 30 cycles : 2 min	During the test no fibre shall break and the attenuation shall be noted before and after the completion of the test. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310 nm and 1550 nm wavelength.

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
6	Torsion Test	The purpose of this test is to determine the ability of an optical fibre cable to withstand torsion.	IEC 794-1-E7 The length of the specimen under test shall be 1 meters and the load shall be 75 N. The sample shall be mounted in the test apparatus with cable clamped in the fixed clamp sufficiently tight to prevent the movement of cable sheath during the test. One end of the cable shall be fixed to the rotating clamp, which shall be rotated in a clockwise direction for one turn. The sample shall then be returned to the starting position and then rotated in an anti-clock wise direction for one turn and returned to the starting position. This complete movement constitutes one cycle. The cable shall withstand ten such complete cycles.	The cable shall be examined physically for any cracks, tearing on the outer sheath and for the damage to other component ports of the cable. The twist mark shall not be taken as damage. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310nm and 1550 nm wave length.
7	Kink Test	The purpose of this test is to verify whether kinking of an optical fibre cable results in breakage of any fibre, when a loop is formed of dimension small enough to induce a kink on the sheath.	IEC 794-1-E10 The small length shall be 10 times the minimum bending radius of the cable. The sample is held in both hands, a loop is made of a bigger diameter and by stretching both the ends of the cable in opposite direction, the loop is made to the minimum bend radius and no kink shall form. The cable is then normaled and attenuation reading is taken.	The kink should disappear after the cable is brought to normal position. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310nm and 1550 n m wavelength.

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
8	Cable Bend Test	The purpose of this test is to determine the ability of an optical fibre cable to withstand repeated flexing. The procedure is designed to measure optical transmittance changes and requires an assessment of any damage occurring to other cable components.	IEC 794-1-E11 (Procedure-I) The fibre and the component parts of the cable shall not suffer permanent damage when the cable is repeatedly wrapped and unwrapped 4 complete turns of 10 complete cycles around a mandrel having diameter of 20 D, where D is the diameter of the cable. The attenuation shall be noted before and after the completion of the test.	The change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310nm and 1550 nm wave length. Sheath shall not show any cracks visible to the naked eye when examined whilst still wrapped on the mandrel.
9	Snatch Test	This test is to determine the ability of the cable to withstand a sudden snatch load.	IEC 794-1-E9 The sample is terminated in a manner that the fibres, sheathing and any strength member/members are clamped together firmly. A hook of dimension ahs a shaft capable of bearing variable loads applied to it. The cable of 4.5 meters length is taken and firmly clamped at the two ends so that a sag of 300 mm., is formed. The attenuation is then measured. Testing load shall be 300 N and the radius of impacting surface of the crown of the hook shall be 12.5 mm. The hook with the mass attached, is held or supported over the cable so that the crown of the hook is centered over the lowest point of the cable at a height of 100 mm. The hook is then released so as to catch the cable after dropping from the height of 100 mm. It shall be repeated ten times. The	There shall be no permanent physical damage to the cable and the change in attenuation of the fibre after the test shall be ≤ 0.05 dB both for 1310nm and 1550 nm wave length.

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
			attenuation is measured. The load is then removed from the cable and attenuation is noted.	
10	Cable Bend Test at High & Low Temperature	To determine the ability of a optical fibre cable to withstand bending at low and high temperatures which might be encountered during cable placement.	EIA RS-455-37 Test Temperature : -30 °C to +70 °C Mandrel dia : 20D (D – dia of the cable) No of turns : 4 Conditioning time duration : 24 hours at each temperature.	Visual test for damage of the sheath shall be checked. The change in attenuation of the fibre after the test shall be ≤ 0.05 dB/Km both for 1310 nm and 1550 nm wave length. The attenuation shall be noted before and after the completion of the cycle.
11	Temperature Cycling	To determine the stability behaviour of the attenuation of a cable subjected to temperature changes which may occur during storage, transportation and usage.	IEC 794-1-F1 (To be tested on 2 Km ± 5% of cable) The permissible temperature range of the cable for storage shall be from –40 °C to +70 °C. The rate of change of temperature during the test shall be 1 degree/minute approx. The cable shall be subjected to temperature cycling for 12 hours at each temperatures as given below: TA2 : –20 °C TA1 : –10 °C TB1 : +60 °C TB2 : +70 °C The test shall be conducted for 2 cycles at the above temperatures.	The change in attenuation of the fibre under test after the test shall be ≤ 0.05 dB both for 1310nm and 1550 nm wave length for entire range of temperature.
12	Cable Aging Test	To check the cable material change dimensionally as the cable ages.	At the completion of temperature cycle test, the test cable shall be exposed to 85 ± 2 degree C for 168 hours. The attenuation measurement at 1310 & 1550 nm wavelengths to be made after stabilisation of the test cable at ambient temperature for 24 hours.	The increase in attenuation allowed : ≤ 0.05 dB at 1310 & 1550 nm wavelengths. *(Note: The attenuation changes are to be calculated with respect to the base line attenuation values*

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
				measured at room temperature before temperature cycling.)
13	Water Penetration Test	To ensure that the installed optical fibre cable will not allow water passage in the cable.	IEC 794-1-F5 (Fig. B) 1992. A circumferential portion of the cable end shall face the water head. The water tight sleeve shall be applied over the cable. The cable shall be supported horizontally and one meter head of water, containing a sufficient quantity of water soluble fluorescent dye for the detection of seepage, shall be applied over the inner sheath for seven days at ambient temperature. No other colour dye is permitted.	No dye shall be detected when the end of the 3m length is examined with UV light detector.
14	Test of Figure of Eight on the cable	To check of easiness in formation of figure of 8 of the cable during installation in the field.	1000 meters (approx) length of the cable shall be uncoiled from the cable reel and shall be arranged in figure of 8. The diameter of each loop of the figure of 8 shall be maximum 2 meters.	It shall be possible to make figure of 8 of minimum 1000 meter length of the cable uncoiled from the cable reel without any difficulty. No visual damage shall occur.
15	Cable Jacket Yield Strength and Ultimate Elongation	To check the yield strength and elongation of polyethylene (HDPE) cable sheath.	FOTP –89 or ASTM D1248 Type III Class. (a) Sample shall be taken from the completed cable (The nylon to be removed for this test). The aged sample shall be conditioned at 100 ± 2 ºC for 120 hours before testing. The cross-head speed shall be 50 mm per minute.	Refer Table A-1 below.
16	Drip Test	To determine the ability of jelly in the cable to withstand a temperature of 70 ºC.	Take a sample of 30 cm length of cable with one end sealed by the end cap. Remove nylon jacket, black sheath binder tape for 5 cm from open end of the sample. Clean the jelly. Then the sample is kept vertically with open end downwards in the oven for 24 hours at 70 ºC with a paper under the sample.	There should be no jelly drip or oil impression on the paper.

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
			Examine the paper placed below the cable sample inside the oven for dripping of the jelly after 24 hours.	
17	ECSR Test	To check the outer sheath of the cable for ECSR.	ASTM D 1693.	There should not be any visible cracks on the surface of the outer sheath, when examined with the help of a magnifying glass.
18	UV Resistance Test	To check the effect of UV radiation on the following: (i) On the outer sheath material (HDPE) (ii) On the Orange colour lines. (iii) On the meter and other legend marking.	ASTM G-53-96 Duration : 2000 hours Four test samples of the finished cable of required length (as per test chamber specifications) are to be prepared. 2 samples shall be kept inside and these test samples are to be compared after test with the other 2 samples kept outside.	There should not be any fading or change in the colour of the marking and that of sheath. *(Note: Earlier Carried out test certificates may be accepted for same raw material and similar design/construction of the cable).*
19	Embrittlement Test of Loose Tube	To check the embrittlement test of the loose tube	The minimum length of the test sample depends of the outside diameter of the loose tube and should be 85mm for tubes up to 2.5mm outside dia. The length of the bigger tubes should be calculated by using the following equation : Lo> 100 x ((D2 + d2)/4)1/2 Where Lo = Length of tube under test D = Outside dia of loose tube. d = inside dia of loose tube. Both the ends of a buffer tube test sample may be mounted in a tool which is clamped in jaws of a tensile machine which exert a constant rate of movement. The	The tube should not get embrittled. No ink should appear on the tube up to the safe bend dia of tube (20 D) where D is the outside diameter of the loose tube. There should not be any physical damage or mark on the tube surface.

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
			movable jaw may move at a rate of 50 mm per minute toward the fixed jaw. Under load the tube will bend, so that the tube is subjected to tensile and compressive stresses. The fixture for holding the tube should be designed in a manner that the tube might bend in all directions without further loading.	
20	Kink Resistance Test on the Loose Tube	To check the kink resistance of the loose tube during installation and in splicing operation	A longer length of the loose tube is taken (with fibre and gel), a loop is made and loop is reduced to the minimum bend radius of loose tube i.e. 20 D. (where D is the outside dia of the loose tube). This test is to be repeated 4 times on the same sample length of the loose tube.	No damage or kink should appear on the surface of the tube.
21	Drainage Test for Loose Tube	To check drainage of the loose tube	A tube length to 40 cm shall be cut and filled with filling gel ensuring there are no air bubbles and the tube is completely full. The filled tube is placed in a horizontal position on a clean worktop and cut 5 cm from each end so that the finished length of the sample is 30 cm. The filled tube shall be left in a horizontal position at an ambient temperature for 24 hrs. The sample tube is then suspended vertically in an environment heat oven over a weighed beaker. It is left in the oven at a temperature of 70 °C for a period of 24 hrs. At the end of the 24 hrs. period the beaker is checked and weighed to see if there is any gel in the beaker.	There shall be no gel or oil in the beaker.
22	Check of Easy removal of Sheath	To check the easy removal of sheath of the optical fibre cable by using normal sheath removal tool.	The sheath shall be cut in circular way using a sheath removal tool and the about 300 mm length of the sheath should be removed in one operation. It should be observed during sheath removal process that no undue extra force is applied and no component part of the cable is damaged.	It shall be possible to remove the sheath easily. Easy removal of both the outer jacket and the inner sheath shall be checked separately.
23	Check of the effect of	To check the effect of	ISO 175.	The sample should not show any effect

S. N.	Name of Test	Objective	Test Method & Procedure	Requirement
	Aggressive Media on the Cable	aggressive media solutions of PH4 and PH10 on the cable.	The two test samples of the finished cable each of 600 mm in length are taken and the ends of the samples shall be sealed. These test samples are put in the PH4 and PH10 solutions separately. After 30 days these samples are taken out from the solutions and examined for any corrosion etc. on the sheath and other markings of the cables.	of these solutions on the sheath and other marking of the cable. *(Note: Earlier Carried out test certificates may be accepted for same raw material and similar design/construction of the cable).*
---End of Table ----				

Table A-1

Jacket material	Minimum Yield Strength		Minimum Elongation (%)
	(Mpa)	(psi)	
HDPE unaged	16.5	2400	400
HDPE aged	12.4	1800	375

3.3.2.8. Type Tests on Aerial FO cable Accessories & fixtures

The accessories and fixtures shall subject to the following tests. The applicability of the tests for the particular type of accessories and fixtures shall be as given below:

Visual Examination : Applicable to all fittings

Objective: To check the quality and the workmanship.

Visual examination shall be carried out for all the accessories and fixtures for quality and workmanship which is required to be of the high order with super quality finish without any manufacturing defects.

Verification of dimensions : Applicable to all fittings

Objective: To check the dimensions of the accessories and fixtures : shall be checked as per approved DRS/drawings.

Tensile strength test : Applicable to tension & suspension clamp assemblies

Objective: To assess the mechanical performance of fixtures under ultimate tensile strength.
Requirement: Cable UTS with factor of safety 1.5

All the load bearing metal fittings except those of elastomer pads and helically formed

fittings shall be tested to meet the above requirement.

Tensile strength test for helically formed product

This test shall be applicable to terminating Helix, Protective Helix and Armour grip suspension helix.

Objective : To check the tensile strength for the helically formed items.

Requirement : The tensile strength test shall be carried out to the method specified in the respective standards for wires and shall meet the requirements listed in earlier clauses.

Slip Strength Test

This test shall be applicable to the Terminating helix and Armoured grip suspension fittings.

Objective : To check the tensile load strength of the formed fittings to assess the performance for withstanding the guaranteed load.

Requirement : The helically formed terminating fittings shall not slip up to 90 % of the Cable UTS. The helically formed suspension fittings shall withstand the load up to a minimum of 25 % of cable UTS and shall slip before 50 % of cable UTS.

Resilience Test

This test shall be applicable to terminating Helix.

Objective : To check the resilience of the helically formed fittings (Terminating Helix)

Requirement : The helically formed fittings shall pass the resilience test while helically formed fittings are wrapped and unwrapped on a piece of optical fibre cable three times successfully. The helical fittings should not loose its resilience even after three applications and shall be able to pass the slip strength test after third application.

Galloping / Fatigue test

This shall be applicable to a complete assembly of one set of tension fittings together with one set of suspension fittings and spiral damper.

Objective : To assess the fatigue performance of fixtures and accessories and the performance of optical characteristics of the optical fibre cable under galloping conditions.

Requirement of test methods:

Length of the span	:	25 – 30 meters
Minimum vibration cycles	:	1 million
Frequency	:	> 30 Hz to 100 Hz.
Amplitude	:	Amplitude of vibration at antinodal points shall not be

less than 100 % of the cable diameter.

Requirement : The accessories and fixtures shall pass the test when tested for the test conditions as above and shall meet the requirement given below:

1. Change in attenuation shall not exceed more than 0.1 dB after the recovery period.
2. No damage on the accessories and fixtures.
3. No physical damage to optical fibre cable.

Aeolian Vibration Test

Objective : To assess the fatigue performance of accessories and fixtures and the optical characteristics of the optical fibre cable under Aeolian vibration.

Requirement of test method :

Minimum length of span : 25 meters.
Minimum vibration cycles : 1 million
Frequency : 10 Hz to 100 Hz.
Amplitude : Free loop peak to peak antinode amplitude shall be maintained at a level equal to one half of the cable diameter.

Requirement :

1. Change in attenuation shall not exceed more than 0.1 dB after the recovery period.
2. No visual damage observed on the accessories and fixtures.
3. No physical damage to optical fibre cable.

Tension and Attenuation Test (Dead End Assembly)

Objective : To assess the attenuation and the optical characteristics of the optical fibre cable after fixing and installing dead end assembly on the optical fibre cable.

Requirement of test method :

Minimum length of span : 25 meters

The test shall meet the following:

a. Change is attenuation shall not exceed more than 0.1 dB after the recovery period.
b. Any visual damage observed on the accessories and fixtures.
c. No physical damage to optical fibre cables.

Wrapping Test

Objective : To check quality of the aluminum alloy wires.

Test Method : The formed fittings made of aluminum alloy wires shall by wrapped on a wire of its own diameter to form a close helix.

Requirement : The wires should not break or show fracture and shall meet the requirement specified above.

Galvanising Test

Objective : To check galvanized coating and the quality of galvanizing on accessories and fixtures

Test method : IS 2633-1972 for uniformity.

Requirement : The fittings shall meet the requirement of the specifications.

Hardness Test of Elastomer pad

Objective : To check the Ploychloroprene compounded elastomer pads of the suspension and cable jumper clamp.

Requirement : The Ploychloroprene compounded elastomer pads of the suspension unit shall be subjected for the test parameters as listed earlier in this specifications. The compounded material should meet the minimum properties specified therein.

3.4. Factory Acceptance Tests

Factory acceptance tests shall be conducted on randomly selected final assemblies of all equipment to be supplied. Factory acceptance testing shall be carried out on OPGW Cable and associated hardware & fittings, Approach Cable and associated hardware fitting , Aerial FO cable(ADSS) and its Accessories & fixtures, Joint Box, FODP, and all other items for which price has been identified separately in the Bid Price Schedules.

Material shall not be shipped to the Employer until required factory tests are completed satisfactorily, all variances are resolved, full test documentation has been delivered to the Employer, and the Employer has issued CIP Clearance/Interim Inspection Report. Successful completion of the factory tests and the Employer approval to ship, shall in no way constitute final acceptance of the system or any portion thereof. These tests shall be carried out in the presence of the Employer's authorised representatives unless waiver for witnessing by Employer’s representatives is intimated to the contractor.

Factory acceptance tests shall not proceed without the prior delivery to and approval of all test documentation by the Employer.
The factory acceptance test shall demonstrate the technical characteristics of the equipment

in relation to these specifications and approved drawings and documents. List of factory acceptance tests for Fibre Optic Transmission system, Termination Equipment Sub-system , NMS are given in specified Tables in this section. This list of factory acceptance tests shall be supplemented by the Contractor's standard FAT testing program. The factory acceptance tests for the other items shall be proposed by the Contractor in accordance with technical specifications and Contractor's (including Sub-Contractor's / supplier's) standard FAT testing program. In general the FAT for other items shall include at least: Physical verification, demonstration of technical characteristics, various operational modes, functional interfaces, alarms and diagnostics etc.

For Test equipment & clock, FAT shall include supply of proper calibration certificates, demonstration of satisfactory performance, evidence of correct equipment configuration and manufacturer's final inspection certificate/ report.

During FAT stage, the employer has to verify all type test reports/certificates including Communication Protocol and security conformance tests of the devices offered for FAT as part of essential cyber security tests. The equipment/system besides for functionality shall also be tested in the factory for vulnerabilities, design flaws, parts being counterfeit or tainted, so as to minimize problems during on-site testing and installation. Cyber security conformance testing are to be carried out in the designated lab as identified by GoI/MoP.

The following auditor report and audit recommendations are to be verified during FAT.

1. Vulnerability assessment
2. Risk assessment
   a. Network architecture validation with respect to design documents.
   b. Penetration testing
   c. System Hardening test

3.4.1. Sampling for FAT

From each batch of equipment presented by the Contractor for Factory acceptance testing, the Employer shall select random sample(s) to be tested for acceptance. Unless otherwise agreed, all required FAT tests in the approved FAT procedures, shall be performed on all samples. The Sampling rate for the Factory acceptance tests shall be minimum 10% of the batch size (minimum 1) for all items. The physical verification shall be carried out on 100% of the offered quantities as per the approved FAT procedure. In case any of the selected samples fail, the failed sample is rejected and additional 20% samples shall be selected randomly and tested. In case any sample from the additional 20% also fails the entire batch may be rejected. In case a number of equipments are required for demonstration of the performance of any equipment during FAT, the sample size shall be taken as that number of equipments which are necessary to demonstrate the performance, irrespective of the percentage.

For the OPGW cable hardware fittings & accessories, the minimum sampling rate, and batch acceptance criteria shall be as defined in IS 2486.

The Sampling rate for the Factory acceptance tests shall be 10% of the batch size (minimum 2) for FO cable drums, FODPs, Joint box and other similar items.

Since FAT testing provides a measure of assurance that the Quality Control objectives are being met during all phases of production, the Employer reserves the right to require the

Contractor to investigate and report on the cause of FAT failures and to suspend further testing/ approvals until such a report is made and remedial actions taken, as applicable.

3.4.2. Production Testing

Production testing shall mean those tests which are to be carried out during the process of production by the Contractor to ensure the desired quality of end product to be supplied by him. The production tests to be carried out at each stage of production shall be based on the Contractor's standard quality assurance procedures. The production tests to be carried out shall be listed in the Manufacturing Quality Plan (MQP), alongwith information such as sampling frequency, applicable standards, acceptance criteria etc.

The production tests would normally not be witnessed by the Employer. However, the Employer reserves the right to do so or inspect the production testing records in accordance with Inspection rights specified for this contract.

3.4.3. Factory Acceptance Tests on Optical Fibre to be supplied with OPGW

The factory acceptance tests listed in table below are applicable for the Optical fibres to be supplied. The listed tests follow testing requirements set forth in IEEE standard 1138. The referenced sections specify the detailed test description. The acceptance norm shall be as specified in the above mentioned IEEE standards unless specified otherwise in the technical specifications.

Table 3-7
Factory Acceptance Tests for Optical Fibres: Optical Tests

S. No.	Test Name	Acceptance Criteria	Test procedure
1	Attenuation Coefficient	TS Vol II ,Table 2-1(a)	EIA/TIA 455- 78A
2	Point Discontinuities of attenuation	TS Vol II, Section 2.1.1.2	EIA/TIA 455-59
3	Attenuation at Water Peak	TS Vol II ,Table 2-1(a)	EIA/TIA 455- 78A
4	Chromatic Dispersion		EIA/TIA 455-168A/169A/175A
5	Core – Clad Concentricity Error		EIA/TIA 455-/176
6	Cladding diameter		EIA/TIA 455-176
7	Fibre Tensile Proof Testing		EIA/TIA 455-31B
-End of table-			

The test report for the above tests for the fibers carried out by the Fiber Manufacturer and used in the OPGW cables shall be shown to the inspector during OPGW cable FAT and shall be submitted along with the OPGW cable FAT report.

3.4.4. Factory Acceptance Test on OPGW Cable

The factory acceptance tests for OPGW cable specified below in Table follow the requirements set forth in IEEE standard 1138 / IEC 60794. The FAT shall be carried out on 10% of offered drums in each lot as specified in technical specifications and the optical tests shall be carried out in all fibres of the selected sample drums. The Rated Tensile Strength test shall be carried out on one sample in each lot.

Table 3-8
Factory Acceptance Tests on OPGW
Applicable standard: IEEE 1138 / IEC 60794

S. No.	Factory Acceptance Test on Manufactured OPGW
1	Attenuation Co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Rated Tensile Strength
5	Lay Length Measurements

3.4.5. Factory Acceptance Test on OPGW Fittings

The factory acceptance tests for OPGW Fittings as specified below in Table 3-9. The sampling plan shall be as per relevant standard:

Table 3-9
Factory Acceptance Tests On OPGW Fittings

S. No.	Factory Acceptance Test
	Suspension Assembly
1	UTS/Mechanical Strength of the assembly
2	Clamp Slip Test
3	Visual Material verification and dimensional checks as per approved DRS/Drawings
4	Mechanical strength of each component
5	Galvanising test
	Tension Assembly
6	Clamp Slip Strength test
7	Visual Material verification and dimensional checks as per approved DRS/Drawings

Table 3-9
Factory Acceptance Tests On OPGW Fittings

S. No.	Factory Acceptance Test
8	Mechanical strength of each component
9	Galvanising Test
Vibration Damper	
10	Galvanising test on damper, masses and messenger wires
11	Damper response (resonant frequencies)
12	Clamp Slip test
13	Strength of messenger wires
14	Attachments of weights to messenger cable
15	Attachments of clamps to messenger cable
16	Clamp bolt tightening test
17	Clamp bolt torque test
18	Dynamic characteristic test.
19	Visual Material verification and dimensional checks as per approved DRS/Drawings
Structure Mounting Clamp	
20	Clamp fit test
21	Clamp Strength test
22	Visual Material verification and dimensional checks as per approved DRS/Drawings
End of Table	

3.4.6. Factory Acceptance Test on Approach Cable

The factory acceptance tests for Approach Cable specified below in Table 3-10:

Table 3-10
Factory Acceptance Tests On Approach Cable

S. No.	Factory Acceptance Test
1	Attenuation Co-efficient at 1310 nm and 1550 nm
2	Point discontinuities of attenuation
3	Visual Material verification and dimensional checks as per approved DRS/Drawings

The test report for the above tests for the fibers as per table 3-7 carried out by the Fiber Manufacturer and used in the OPGW cables shall be shown to the inspector during OPGW cable FAT and shall be submitted along with the OPGW cable FAT report.

3.4.7. Factory Acceptance Test on Splice Enclosure (Joint Box) /FODP

The factory acceptance tests for Splice Enclosures/FODP as specified below in Table:

Table 3-11
Factory Acceptance Tests on Splice Enclosures (Joint Box)/FODP

S. No.	Factory Acceptance Test
1	Visual check of Quantities and Specific Component Number for each component of Splice Enclosure/FODP and dimensional checks against the approved drawings.

3.4.8. Factory Acceptance Test on Test Equipment, Pigtail & other items

As per technical specification and approved DRS/Documents.

3.4.9. Factory Acceptance Tests on Self-supporting metal free Aerial optical fibre cable

The tests listed in Table 7-20 shall be carried out as Factory Acceptance Test for Self-supporting metal free aerial optical fibre cable meeting the requirements specified in this section. The factory acceptance tests for optical fibers listed in table 3-7 are applicable for the fibers in the ADSS cable. The factory acceptance test report for the optical fibers carried out by the Fiber Manufacturer and used in the Self-supporting metal free Aerial optical fibre cable (ADSS) shall be shown to the inspector during ADSS cable FAT and shall be submitted along with the ADSS cable FAT report.

Table 3-12
Factory Acceptance Tests on Self Supporting Metal Free Aerial Fibre Optic Cable

S. No.	Factory Acceptance Test
1	Attenuation Coefficient (1310, 1550): By EIA/TIA 455- 78A or OTDR
2	Point discontinuities of attenuation: By EIA/TIA 455- 78A or OTDR
3	Visual Material verification and dimensional checks as per approved drawings
4	Water Ingress test
5	Tensile strength test / Strain test
6	Impact test
7	Kink test
8	Environmental test
9	Crush Test
10	Drip test

3.4.10. Factory Acceptance Tests on Aerial FO cable accessories & fixtures

The FAT on accessories & fixtures of Self-supporting metal free aerial optical fibre cable shall be carried out as specified in Table 3-13.

Table 3-13
Factory Acceptance Tests on Fittings for Self Supporting Metal Free Aerial FO Cable

S. No.	Factory Acceptance Test
1	Visual and dimensional checks of all components
2	Tensile test
3	Slip test
4	Galvanising test
5	Wrapping test
6	Hardness test

3.5. Site Acceptance Tests

The Contractor shall be responsible for the submission of all equipment & test equipment supplied in this contract for site tests and inspection as required by the Employer. All equipment shall be tested on site under the conditions in which it will normally operate.

The tests shall be exhaustive and shall demonstrate that the overall performance of the contract works satisfies every requirement specified. At a minimum Site Acceptance Testing requirement for FO cable, etc. is outlined in following section. This testing shall be supplemented by the Contractor's standard installation testing program, which shall be in accordance with his quality plan(s) for FO installation. The tests to be conducted during SAT are specified in respective section.

During the course of installation, the Employer shall have full access for inspection and verification of the progress of the work and for checking workmanship and accuracy, as may be required. On completion of the work prior to commissioning, all equipment shall be tested to the satisfaction of the Employer to demonstrate that it is entirely suitable for commercial operation.

3.5.1. Minimum Site Acceptance Testing Requirement for FO Cabling

Prior to installation, every spooled fibre optic cable segment shall be tested for compliance with the Pre-shipment data previously received from the manufacturer. This requirement will preclude the installation of out of specification cable segments that may have been damaged during shipment.

3.5.1.1. Phases of Site Acceptance Testing

SAT shall be carried out link by link from FODP to FODP. SAT may be performed in parts in case of long links.

The tests, checks, adjustments etc conducted by the Contractor prior to offering the equipment for SAT shall be called Pre-SAT activities. The Pre-SAT activities shall be described in the installation manuals and Field Quality Plan documents.

Sag and tension of OPGW shall generally be as per approved sag-tension chart and during installation, sag and tension of OPGW shall be documented. Upon completion of a continuous cable path, all fibres within the cable path shall be demonstrated for acceptance of the cable path. Fibre Optic cable site testing minimum requirements are provided in Table 3-14(a) through 3-14(c) below:

Table 3-14(a)
Fibre Optic Cable Pre-Installation Testing

Item:	Description:
1.	Physical Inspection of the cable assembly for damage
2.	Optical fibre continuity and fibre attenuation with OTDR at 1550 nm
3.	Fibre Optic Cable length measurement using OTDR

Table 3-14(b)
Fibre Optic Cable Splicing Testing

Item:	Description:
1.	Per splice bi-directional average attenuation with OTDR
2.	Physical inspection of splice box/enclosure for proper fibre / cable routing techniques
3.	Physical inspection of sealing techniques, weatherproofing, etc.

Table 3-14(c)
Fibre Optic Cable Commissioning Testing

Item:	Description:
1.	End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by OTDR.
2.	End to End (FODP to FODP) bi-directional average attenuation of each fibre at 1310 nm and 1550 nm by Power meter.
3.	Bi-directional average splice loss by OTDR of each splice as well as for all splices in the link (including at FODP also).
4.	Proper termination and labelling of fibres & fibre optic cables at FODP as per approved labelling plan.
-End of Table-	

3.6. QUALITY ASSURANCE PROGRAMME

To ensure that the equipment and services under the scope of this Contract, whether manufactured or performed within the Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work as applicable, are in accordance with the specifications, the Contractor shall ensure suitable quality assurance programme to control such activities at all points necessary. A quality assurance programme of the Contractor shall be in line with ISO requirements & shall generally cover the following :

a) The organisation structure for the management and implementation of the proposed quality assurance programme.

b) System for Document and Data Control.

c) Qualification and Experience data of Bidder's key personnel.

d) The procedure for purchases of materials, parts, components and selection of sub-Contractor's services including vendor analysis, source inspection, incoming raw material inspection, verification of material purchases etc.

e) System for shop manufacturing and site erection controls including process controls, fabrication and assembly control.

f) System for Control of non-conforming products including deviation dispositioning, if any and system for corrective and preventive actions based on the feed back received from the Customers and also internally documented system for Customer complaints.

g) Inspection and test procedure both for manufacture and field activities.

h) System for Control of calibration of testing and measuring equipment and the indication of calibration status on the instruments.

i) System for indication and appraisal of inspection status.

j) System of Internal Quality Audits, Management review and initiation of corrective and Preventive actions based on the above.

k) System for authorising release of manufactured product to the Employer.

l) System for maintenance of records.

m) System for handling, storage and delivery.

n) A quality plan detailing out the specific quality control measures and procedure adopted for controlling the quality characteristics relevant to each item of equipment furnished and /or service rendered.

o) System for various field activities i.e. unloading, receipt at site, proper storage, erection, testing and commissioning of various equipment and maintenance of records. In this regard, the Employer has already prepared Standard Field Quality Plan for transmission line/substation equipments as applicable, Civil/erection Works which is required to be followed for associated works.

The Employer or his duly authorised representative reserves the right to carry out quality audit and quality surveillance of the system and procedure of the Contractor/his vendor's quality management and control activities.

Quality Assurance Documents

The Contractor shall ensure availability of the following Quality Assurance Documents:

i) All Non-Destructive Examination procedures, stress relief and weld repair procedure actually used during fabrication, and reports including radiography interpretation reports.

ii) Welder and welding operator qualification certificates.

iii) Welder's identification list, welding operator's qualification procedure and welding identification symbols.

iv) Raw Material test reports on components as specified by the specification and in the quality plan.

v) The Manufacturing Quality Plan(MQP) indicating Customer Inspection Points (CIPs) at various stages of manufacturing and methods used to verify that the inspection and testing points in the quality plan were performed satisfactorily.

vi) Factory test results for testing required as per applicable quality plan/technical specifications/GTP/Drawings etc.

vii) Stress relief time temperature charts/oil impregnation time temperature charts, wherever applicable.

3.7. INSPECTION, TESTING & INSPECTION CERTIFICATE

3.7.1 Contractor shall procure bought out items from sub-vendors as per the list in "Compendium of Vendors" available on POWERGRID web-site www.powergridindia.com after ensuring compliance to the requirements/conditions mentioned therein. Contractor shall explore first the possibilities of procuring the bought out items from POWERGRID approved existing vendors. In case of their unavailability / non-response, Contractor may approach POWERGRID for additional sub-vendor approval. In that case, the assessment report of proposed sub vendor by Contractor along with the enclosures as per Annexure-I shall be submitted within 60 days of the award. The proposal shall be reviewed and approval will be accorded based on the verification of the document submitted and/or after the physical assessment of the works as the case may be. The physical assessment conducted by POWERGRID, if required, shall be on chargeable basis. Charges shall be as per the POWERGRID norms prevailing at that time, which shall be intimated by POWERGRID separately. If proposal for sub-

vendor is submitted after 60 days, the Contractor's proposal normally will not be considered for current LOA. However, POWERGRID may process the case for developing more vendors for referred items, if found relevant. In all cases, It is the responsibility of the Contractor that Project activities do not suffer on account of delay in approval/non approval of a new sub-vendor.

For Telecom/LD&C packages, the makes/model of small items shall be finalized during approval of DRS by Telecom/LD&C department.

The responsibility and the basis of inspection for various items & equipment is placed at **Annexure-II** along with the requirement of MQP (Manufacturing Quality Plan), ITP(Inspection & Test Plan), FAT(Factory Acceptance Test) which should be valid & POWERGRID approved and Level of inspection envisaged against each item.

Contractor shall ensure that order for items where MQP/ITP/FAT is required will be placed only on vendors having valid MQP/ITP/FAT and where the supplier's MQP/ITP/FAT is either not valid or has not been approved by POWERGRID, MQP shall be generally submitted as per POWERGRID format before placing order. A Copy of MQP format is placed at **Annexure – III.**

Items not covered under MQP/ITP/FAT shall be offered for inspection as per POWERGRID LOA/technical Specifications/ POWERGRID approved data sheets/ POWERGRID approved drawings and relevant Indian / International standards.

Inspection Levels: For implementation of projects in a time bound manner and to avoid any delay in deputation of POWERGRID or its authorized representative, involvement of POWERGRID for inspection of various items / equipment will be based on the level below:

Level –I: Contractor to raise all inspection calls and review the report of tests carried out by the manufacturer, on his own, as per applicable standards/ POWERGRID specification, and submit to concerned POWERGRID inspection office/Inspection Engineer. CIP/MICC will be issued by POWERGRID based on review of test reports/certificates of manufacturers.

Level – II: Contractor to raise all inspection calls and carry out the inspection on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during inspection, the same would be intimated to Contractor and CIP/MICC will be issued by POWERGRID. Else, Contractor would submit their test reports/certificates to POWERGRID. CIP/MICC will be issued by POWERGRID based on review of test reports / certificates.

Level - III: Contractor to raise inspection calls for both, stage (as applicable) & final inspection and carry out the stage inspections(if applicable) on behalf of POWERGRID on the proposed date of inspection as per applicable standards/specification. However, in case POWERGRID wishes to associate itself during stage inspection, the same would be intimated to Contractor and CIP will be issued by POWERGRID. Else, Contractor would submit the test reports / certificates of stage inspection after their own review and CIP will be issued by POWERGRID based on review of test reports / certificates. Final inspection will be carried out by POWERGRID and CIP/MICC will be issued by POWERGRID.

Level – IV: Contractor to raise inspection calls for both, stage (as applicable) & final inspections. POWERGRID will carry out the inspection for both stage & final inspection as per applicable standards/specification and CIP/MICC will be issued by POWERGRID.

Contractor shall ensure that to implement the above inspection levels, particularly for the quality control and inspection at sub-vendor's works, they would depute sufficient qualified & experienced manpower in their Quality Control and Inspection department. Further, to assure quality of construction, Contractor shall have a separate workforce having appropriate qualification & experience and deploy suitable tools and plant for maintaining quality requirement during construction in line with applicable Field Quality Plan (FQP).

The Employer, his duly authorised representative and/or outside inspection agency acting on behalf of the Employer shall have at all reasonable times access to the Contractor's premises or Works and shall have the power at all reasonable times to ensure that proper Quality Management practices / norms are adhered to, inspect and examine the materials & workmanship of the Works, to carry out Quality/Surveillance Audit during manufacture or erection and if part of the Works is being manufactured or assembled at other premises or works. The Contractor shall obtain for the Employer and for his duly authorised representative permission to inspect as if the works were manufactured or assembled on the Contractor's own premises or works. The item/equipment, if found unsatisfactory with respect to workmanship or material is liable to be rejected. The observations for improvements during product/ process inspection by POWERGRID shall be recorded in Quality Improvement Register (available & maintained at works) for review & timely compliance of observations.

Contractor shall submit inspection calls over internet through POWERGRID website. The required vendor code and password to enable raising inspection call will be furnished to the main Contractor with in 30 days of award of contract on submission of documents by Contractor. After raising the

inspection calls, Contractor shall then proceed as per the message of that particular call which is available on the message board.

The Employer reserves the right to witness any or all type, acceptance and routine tests specified for which the Contractor shall give the Employer/Inspector Twenty one (21) days written notice of any material being ready for testing for each stage of testing as identified in the approved quality plan as customer inspection point(CIP) for indigenous inspections. All inspection calls for overseas material shall be given at least forty five (45) days in advance. Such tests shall be to the Contractor's account except for the expenses of the Inspection Engineer. The Employer/inspector, unless witnessing of the tests is waived by Employer, will attend such tests within Twenty one (21) days of the date of which the equipment is notified as being ready for test/inspection, failing which the Contractor may proceed with the test which shall be deemed to have been made in the Inspector's presence and he shall forthwith forward to the Inspector three copies of tests, duly certified. Contractor shall ensure, before giving notice for type test, that all drawings and quality plans have been got approved. The equipment shall be dispatched to site only after approval of Routine and Acceptance test results and Issuance of Dispatch Clearance in writing by the Employer. CIP/Material Inspection clearance certificate (MICC) shall be issued by the Employer after inspection of the equipment or review of test reports as applicable. Employer may waive off the presence of Employer's inspecting engineer. In that case test will be carried out as per approved QP and test certificate will be furnished by the supplier for approval. CIP/MICC will be issued only after review and approval of the test reports.

Contractor shall generally offer material for inspection as per supply bar chart approved by POWERGRID and not before 30 days from schedule indicated in the bar chart. In case Contractor offers material(s) for inspection prior to 30 days from the scheduled date with necessary approval of POWERGRID, POWERGRID shall inspect the material and issue CIP only. However, in such an exceptional case, MICC shall be issued only as per provision of original / revised approved supply schedule.

Contractor shall minimize the number of inspection calls by offering optimum quantities in each inspection call at the respective manufacturer's works.

Contractor shall inspect the material themselves and only after they are fully convinced about the Quality, they shall offer the material for POWERGRID inspection and shall also ensure that relevant portion of LOA/NOA, approved drawing and data sheets along with applicable Quality Plans are available at the works of Contractor or their Sub-vendor before the material is offered for inspection.

Contractor shall ensure that material which has been cleared for dispatch after inspection will be dispatched within 30 days in case of domestic supplies and within 60 days in case of Off-shore supplies from the date of issuance of CIP. Material which is not dispatched within stipulated time as above will be reoffered for POWERGRID inspection or specific approval of POWERGRID QA&I shall be obtained for delayed dispatch .

The Employer or IE shall give notice in writing to the Contractor, of any objection either to conformance to any drawings or to any equipment and workmanship which in his opinion is not in accordance with the Contract. The Contractor shall give due consideration to such objections and shall either make the modifications that may be necessary to meet the said objections or shall confirm in writing to the Employer/Inspection Engineer giving reasons therein, that no modifications are necessary to comply with the Contract.

All Test Reports and documents to be submitted in English during final inspection of equipment by POWERGRID or as and when required for submission.

When the factory tests have been completed at the Contractor's or Sub-Contractor's works, the Employer/Inspection Engineer(IE) shall issue a certificate to this effect within fifteen (15) days after completion of tests & submission of documents by Contractor/manufacturer but if the tests are not witnessed by the Employer/IE, the certificate shall be issued within fifteen (15) days of receipt of the Contractor's Test certificate by the Employer/IE. Contractor shall, on completion of all tests, submit test reports within Ten (10) days to POWERGRID IE. Failure of the Employer/IE to issue such a certificate shall not prevent the Contractor from proceeding with the Works. The completion of these tests or the issue of the certificate shall not bind the Employer to accept the equipment should, it, on further tests after erection, be found not to comply with the Contract.

In all cases, where the Contract provides for tests whether at the premises or works of the Contractor or of any Sub- Contractor, the Contractor, except where otherwise specified, shall provide free of charge such items as labour, materials, electricity, fuel, water, stores, apparatus and instruments as may be reasonably demanded by the Employer/Inspector or his authorised representative to carry out effectively such tests of the equipment in accordance with the Contract and shall give facilities to the Employer/Inspection Engineer or to his authorised representative to accomplish testing.

The inspection and acceptance by Employer and issue of Inspection Certificate thereon shall in no way limit the liabilities and responsibilities of

the Contractor in respect of the agreed quality assurance programme forming a part of the Contract, or if such equipment is found to be defective at a later stage.

The Employer will have the right of having at his own expenses any other test(s) of reasonable nature carried out at Contractor's premises or at site or in any other place in addition of aforesaid type and routine tests, to satisfy that the material comply with the specification.

The Employer reserves the right for getting any additional field tests conducted on the completely assembled equipment at site to satisfy that material complies with specifications.

Rework/ Re-engineering, if any, on any item/equipment shall be carried out only after mutual discussions and in accordance with mutually agreed procedure. Contractor shall submit Joint Inspection Report of equipments under Re-Work/Re-Engineering alongwith procedure for the same to POWERGRID for approval, before taking up the Re-Work/Re-Engineering, failing which POWERGRID reserves the right to reject the equipment.

Contractor may establish a field test Laboratory to execute Civil Construction testing requirements at site with the condition that all testing equipment shall be calibrated from POWERGRID approved accredited Testing laboratories, with calibration certificates kept available at site and all testing personnel employed in the Field Testing Laboratories to be qualified and experienced Engineers or testing to be carried out at POWERGRID approved Third Party Laboratories.

Contractor shall ensure that all possible steps are taken to avoid damages to the equipment during transport, storage and erection.

The Employer reserves the right to increase or decrease their involvement in inspections at Contractor's Works or at his Sub-Contractor's premises or at the Employer's site or at any other place of Work based on performance of Contractor/sub Contractor.

Annexure-I

Assessment report from Contractor for proposed sub-vendor along with following enclosures (to the extent available):

1. Registration / License of the works
2. Organization chart with name and qualification of key persons
3. List of Plant and Machinery.
4. List of testing equipment with their calibration status.
5. List of Raw material, bought out items with sourcing details
6. List of out-sourced services with sourcing details.
7. List of supply in last three years.
8. Third party approval, if any (viz. ISO, BIS),
9. Pollution clearance wherever applicable
10. Energy Conservation & Efficiency report
    (Applicable to industries having contract load more than 100 KVA)
11. Formats for RM, in process and acceptance testing
12. Type test approvals conducted in last 5 years, if applicable
13. Performance Certificates from customers
14. Photographs of factory, plant and machinery & testing facilities

Annexure-II

MQP & INSPECTION LEVEL REQUIREMENT

Sl. No.	Item / Equipment	Requirement of MQP/ITP/FAT	Inspection Level
1	Fibre optic Cable	Yes	III
2	OPGW & H/W (incl. Joint Box)	Yes	III
3	FODP including pigtail	No	II
4	Hardware Fittings for Fibre Optic cable	Yes	III
5	HDPE Pipe	No	II

Note:

* **MICC for test and measuring equipment shall be issued only after actual verification/demonstration of satisfactory performance at site.**

** **Though level 2 items, CIP can be issued also on review of TCs and visual inspection of these items.**

Annexure- III

MANUFACTURING QUALITY PLAN

	Manufacturers Details (Name, Works Address etc.)	**Customer** **POWERGRID**	**Vendor's Code:**	**Item:**	**Q.P. No.** **Rev. No.** **Date:**	**Valid From:** **Valid Upto:**

Sr. No.	**Components / Operations & Description of Test**	**Type of check**	**Quantum of Check / Sampling with basis**	**Reference document for Testing**	**Acceptance Norms**	**Format of Record**	**Applicable Codes**						**Remarks**
							1	**2**	**3**	**4**	**5**	**6**	
A. Section: RAW MATERIAL INSPECTION													
B. Section : IN PROCESS INSPECTION													

C. Section: FINAL TESTING **D. Section: PACKING & DISPATCH**													

MANUFACTURING QUALITY PLAN **Page 2 of 2**

		Customer **POWERGRID**	**Vendor's Code:**	**Item:**	**Q.P. No.** **Rev. No.** **Date:**	**Valid From:** **Valid Upto:**

Code 1	Indicates place **where testing is planned** to be performed i.e. Inspection location	**Code 2**	Indicates **who has to perform the tests** i.e. Testing Agency
A	At Equipment Manufacturer's works	J	The Equipment Manufacturer
B	At Component Manufacturer's works	K	The Component Manufacturer
C	At Authorised Distributor's place	L	The Third Party
D	At Independent Lab	M	The Turnkey Contractor
E	At Turn Key Contractor's location		
F	Not specified		
Code 3	Indicates **who shall witness** the tests i.e. Witnessing Agency	**Code 4**	Review of Test Reports/Certificates
P	Component Manufacturer itself	W	By Equipment manufacturer during raw material/bought out

			component Inspection.
Q	Component Manufacturer and Equipment Manufacturer	X	By Contractor during product/process inspection
R	Component Manufacturer, Equipment Manufacturer and Contractor	Y	By POWERGRID during product/process inspection
S	Equipment Manufacturer itself	Z	By Contractor and/or POWERGRID during product/process inspection
T	Equipment Manufacturer and Contractor		
U	Equipment Manufacturer, Contractor and POWERGRID		
V	Third Party itself		
Code 5	Whether specific approval of sub-vendor / Component make is envisaged?	**Code 6**	Whether test records required to be submitted after final inspection for issuance of CIP/MICC
E	Envisaged	Y	Yes
	Not Envisaged	N	No

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